THE SPREAD AND IMPACT OF THE INTRODUCED VESPINE WASPS *VESPULA GERMANICA* (F.) AND *VESPULA VULGARIS* (L.) (HYMENOPTERA: VESPIDAE: VESPINAE) IN TASMANIA

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Abstract

The dispersal since introduction and current distribution of the two vespine wasps present in Tasmania, *Vespula germanica* (F.) and *Vespula vulgaris* (L.), is documented. The economic effects on agriculture, forestry and tourism are outlined and an appraisal of possible environmental impacts made.

Introduction

The European wasp, *Vespula germanica* (F.), was first found to be established in Australia in the Hobart suburb of Battery Point in 1959 (Anon 1960). Since then this species has expanded its range throughout the settled regions of the island and in recent years become firmly established in National Parks, uninhabited areas of the south-west and rainforest areas in north-western Tasmania.

Originating in Europe and the Mediterranean region, *V. germanica* is now widespread throughout the world including North America, Chile, South Africa, New Zealand and Australia. Its presence in New Zealand dates from sightings in the 1920s but it was not confirmed as established until 1944 (Thompson 1982). The species spread throughout New Zealand in about six years, its rapid dispersal accelerated by its survival through the relatively mild winters of the region. A similar event occurred in Tasmania following confirmed establishment in 1959 in Hobart. Within ten years the wasp had become widely established in the north of the state and within a further five years penetrated the rainforests of the west coast and now occupies most of the state. The number of nests established in high rainfall areas fluctuated annually but in recent years *V. germanica* seems to have gained a permanent foothold in many areas thought to be marginal for its establishment.

The English wasp, *Vespula vulgaris* (L.), a species similar in appearance to the European wasp, has recently been found established in southern Tasmania (Matthews *et al.* 2000). Examination of museum specimens shows that the species has been present in the Hobart area since 1995 and is currently restricted to the south east of the state. *V. vulgaris* was first found in Australia in the Melbourne area in 1958 and has not greatly expanded its range. In New Zealand this species is widespread throughout most of the country and in some areas, such as the South Island beech forests, has usurped *V. germanica* (Clapperton *et al.* 1994).

General life history

The adult workers of both *Vespula* species are primarily protein feeders and are swift, voracious hunters of many insects, especially larger Diptera and honeybees. The wasps also gorge on ripe fruits such as apples, plums, grapes and berry fruits as well as meat from carrion and barbecue areas.

Overwintering queens emerge from hibernation in spring and establish new nests. The nests are never exposed, usually being found in hollow trees, under rock slabs, in cavity brick walls or under big logs. They are constructed from wood fibres collected by the workers and mixed with saliva to form a papier-mache nest filled with breeding cells. Eggs are laid in the golf ball-sized nest and the first adult workers emerge several weeks later. Workers live for several weeks, continually increasing the size of the nest. Increasing numbers of adult workers are produced during the summer months with populations peaking at up to 20,000-30,000 workers per nest in March/April. Workers tend to forage within 200 metres of the nest but individuals may travel up to a kilometre. In autumn the nests begin to decline and several hundred queens and male wasps are produced in larger cells. Mating occurs outside the nest, the drones die and the queens migrate to find overwintering sites. The remaining workers usually die, leaving the nest deserted. However in well-sheltered nests resident queens and workers may survive and remain active during the winter, resulting in increased nest size and large wasp populations the following year. These nests may survive and enlarge for up to three seasons. The largest recorded *V. germanica* nest in Tasmania occupied 2.268 cubic metres in volume (Lewis 1975).

Most wasp colonies in Europe die out over the winter months, with overwintering queens re-establishing nests each spring. There is only one generation a year. The survival of the nest, which can house up to 100,000 insects, is temperature dependent, with mortality occurring at 0°C after 12 hours (Madden 1981). High rainfall and prolonged periods of frost and snow may limit the permanent distribution of the wasps in some areas of Tasmania although *V. vulgaris* is able to survive in colder and wetter sites than *V. germanica* (Beggs 1991).

Pest status

Vespid wasps cause crop losses to many agricultural industries especially soft fruit orchards, horticultural ventures, apiaries and the wine and grape industries. Their presence and aggressive nature pose health threats to outdoor workers in agriculture, forestry and tourism. Both species are aggressive if individuals or the nest are disturbed and pose a hazard to people using machinery during forestry and agricultural operations or in recreational areas such as picnic grounds.

European wasps are economic pests of beehives, robbing them of honey and killing worker bees when foraging. No estimates of losses are available from

Tasmania but in New Zealand destruction of 1.9% of all hives and damage to another 4.9% of hives in 1974/75 resulted in serious losses to the industry (Walton and Reid 1976). By 1986/87 the annual total of destroyed and damaged hives had risen to 9.35% (Clapperton *et al.* 1989). Movement of wasps into native forest areas also deprived beekeepers of considerable potential honey production as a result of competition with bees for honeydew in beech forests (Crosland 1989). However, a Tasmanian study did not demonstrate any significant competition between wasps and bees for the leatherwood flower resource used for honey produced in wet forest areas (Ettershank and Ettershank 1993).

The increased area of grapes grown for wine production in Tasmania provides an attractive food source for wasps in autumn when foraging activity is at its peak. Although losses in Tasmania have not been documented, in the 1999/2000 season several southern vineyards reported a loss of grape production of up to 25%. This was due to fruit damage to grapes being hollowed out by wasps; consequently picking was brought forward by several weeks to minimise crop losses. Trapping in some vineyards in the south of the state has shown the presence of both *Vespula* species. In Victoria losses of 10-15% of the total crop due to damage by *V. germanica* has been recorded (Thomas 1993). Wasp damage in some vineyards in Victoria was responsible for bringing the harvest date forward and in recent years there has been an increased incidence of pickers and processors being stung (Darby *et al.* 1998). Wasp feeding reduces the content of the grape and also introduces foreign yeast types that can interfere with the fermentation process (M. Williams, pers. com.).

One Tasmanian commercial grower of strawberries reported a 20% loss in fruit production in 2000 due to wasp damage. The wasps are attracted to sugary substances and aggregations can occur at fruit processing plants and fruit and confectionery shops.

Although not reported in Tasmania, in Israel there has been an increasing incidence of European wasps feeding on milk from lactating dairy cattle, causing bacterial ulcers affecting up to 65% of cows in some herds. There was also a higher incidence of nests on dairy farms (Braverman 1998).

Spread of *Vespula germanica* in Tasmania

Records of wasp sightings and nests were compiled from newspaper reports, observations of forestry workers and public inquires as well as personal observations. Figure 1 shows the distribution throughout the state for each decade since establishment based on confirmed sightings. Spradbery and Maywald (1992) stated that by 1974 the wasp was widespread throughout Tasmania. Since then there have been periods of several years in western coastal areas where wasp populations have been very low due to high rainfall flooding nests. However, since the early 1990s populations have been high.

This suggests that the occupancy of good nesting sites had enabled the population to recolonise flooded sites or marginal habitats quickly. Several very large nests have been found, especially among the roots of large dead eucalypts, in very high rainfall areas (<2000 mm per annum), suggesting occupancy for several years. This trend of permanent occupancy of good nest sites has occurred throughout the state over the period of establishment, ensuring that there will always be high wasp populations in Tasmania. The experience in New Zealand suggests that this 'permanency' phase may take up to 20 years to be achieved before a plateau of population numbers will occur. The other moderating factor to permanent establishment is the food resource.

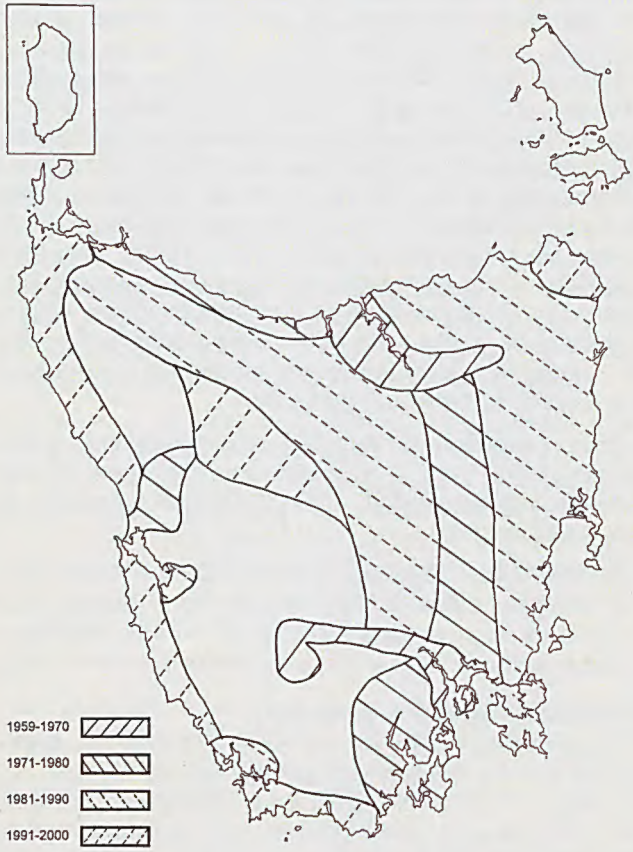

Fig. 1. Distribution of the European wasp, *Vespula germanica*, in Tasmania for each decade since introduction.

Spradbery and Maywald (1992) noted that the initial establishment and spread of *V. germanica* is largely dependent on man and the urban environment. Colonisation of sub-optimal habitats is dependent on suitable nest sites, over-wintering sites for queens and a food resource that can sustain high wasp populations. Nest density is dependent on site availability. In New Zealand at a disturbed land site the density reached 75 nests per hectare (Szabo 1993).

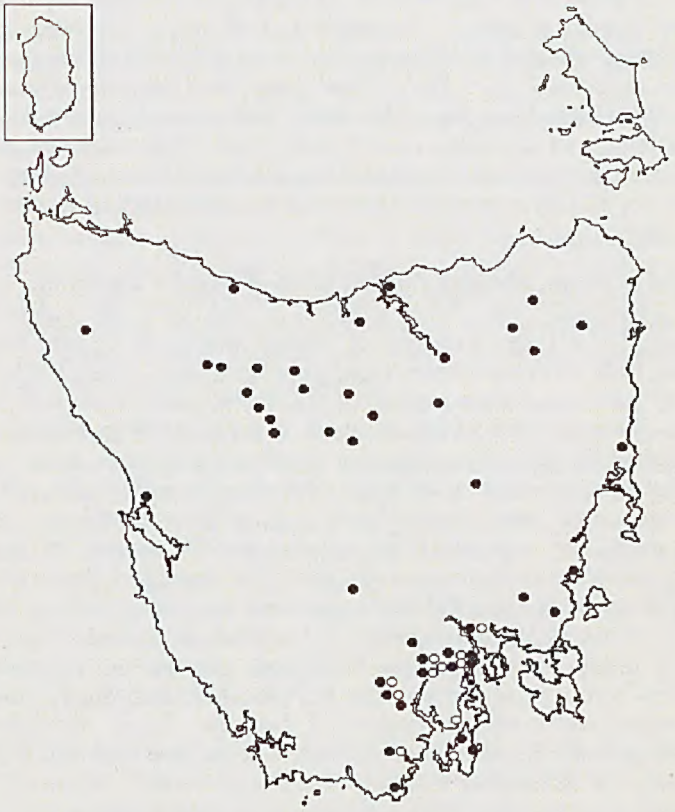

Fig. 2. Distribution of *Vespula germanica* (●) and *V. vulgaris* (○) in Tasmania from a survey conducted in April 2000.

Spread of *Vespula vulgaris* in Tasmania

Following the discovery of *V. vulgaris* at Warra in the south of the state (Matthews *et al.* 2000), an examination of museum specimens determined presence in the Hobart area dating from 1995. A small survey was conducted

during April 2000, during which Forestry Tasmania staff, Australian Entomological Society members and university students collected vespid wasps either by live capture or utilising commercial wasp traps. Totals of 745 *V. germanica* and 51 *V. vulgaris* wasps were collected from 47 sites (Fig. 2). *V. germanica* was collected at all but one site while *V. vulgaris* was present at most sites south of and including Hobart suburbs. *V. vulgaris* was not found at midland or northern sites. At most sites small numbers of wasps were collected. At sites where both species coexisted, *V. vulgaris* was in low numbers compared with *V. germanica*. At one Hobart suburban site however, *V. vulgaris* dominated (ratio of 4:1, n = 65). At Warra, where large numbers of wasps were collected at nine sites, the ratio of the two species in 1999-2000 was almost 1:1 (n = 316). Clearly trap position will influence the numbers of each species captured if a trap is inadvertently placed near a nest. The distribution of *V. vulgaris* may have been underestimated and its presence at some sites overlooked, given the low catches at many sites. However, out of 111 specimens collected in the state north of Hobart, none was *V. vulgaris*.

Movement of wasps into high rainfall areas of western Tasmania

Vespula germanica was first recorded in the west of Tasmania at Queenstown in 1971 and in the coastal Strahan area in 1974. There seems to have been little movement from these population areas until 1988, when wasp nests were found at the top end of Macquarie Harbour and then at Port Davey in 1991. By 1997 all coastal areas of the South-West National Park were inhabited. In some areas along the southern coastal track many walkers complained of large numbers of wasps attending campsites. The north and central-west coastal areas, including the Arthur River rainforest, were all occupied in 1987 by well-established populations. The coastal strip between the Arthur and Pieman Rivers was one of the last regions of Tasmania to be regularly occupied but by 1993 the wasps were a common sight to forestry and survey workers (Mesibov 1993). Since 1993 there have been yearly reports of nests throughout the south-west regions of Tasmania by bushwalkers, forestry and national park workers, indicating that the wasp has become established in western regions of Tasmania. Initial colonisation in favourable seasons enables nests to be built in marginal sites, which subsequently are effected by flooding or low temperatures. However, initial colonisation also enables good sites to be occupied and support later movement into marginal areas.

Vespula vulgaris is reported as being more tolerant of colder and wetter conditions and higher altitude than *V. germanica*. With the establishment of this species in Tasmania it may be able to colonise areas which are marginal for *V. germanica* (Fordham *et al.* 1991, Beggs 1991). Of concern are the potential occupation of the interior of the South-West National Park and the alpine regions of central Tasmania.

Impact on native fauna

The establishment, in the southern forests of Tasmania, of a long-term ecological research site (Warra LTER site) where research into sustainable logging systems is being conducted, provided the opportunity to examine the impact of the *Vespula* species on the native invertebrate fauna. As part of baseline invertebrate studies, using Malaise traps, *Vespula* species have been captured at nine routinely monitored sites in sufficient numbers to enable some initial impact comments to be made.

During the initial set up of the Warra site, involving cutting tracks and marking boundaries during the summer months of 1996/97, workers did not observe the presence of *Vespula* species. This suggests that, if present, populations and nest numbers were very low. Since mated queens and foraging workers rarely fly more than one kilometre (Rogers 1972), nest establishment at the Warra site appears to have commenced in the summer of 1996/97 with migration from Tahune Park, adjacent to Huon River, where *V. germanica* has been present for at least 15 years. The wasps appear to have followed the new road and colonised disturbed roadside ground, then moved mainly into logged coupes containing very disturbed ground and then into nearby native forest. Native forest, on the edge of logged coupes, is used by foraging workers of both *Vespula* spp., with *V. germanica* preferring open areas and avoiding areas of closed canopy.

At Warra, between November and June in 1997-1998, wasps were collected at nine Malaise trap sites distributed throughout a two square kilometre area. Low trap catches of between 1-9 wasps per trap [mean 1.29 (64 trap times)] were recorded. In 1998/99 during the same months, all sites recorded captures of between 1-50 wasps per trap [mean 8.9 (61 trap times)]. In 1999/2000 traps captured 1-42 wasps per trap [mean 8.6 (35 trap times)]. Table 1 presents the capture over time of the two wasp species at Warra. Two Malaise traps situated in an open logged area accounted for 20% of the total wasps caught. In the three seasons of sampling a total of 854 wasps was captured in the Malaise traps.

In 1998/99 seven wasp nests were found at newly disturbed roadside sites along the length of the study area and two nests were found in an undisturbed coupe. No nests were found in 1997/98. High populations of wasps were present during March to June in both 1999 and 2000 in a coupe logged the previous winter, where there were many nests in disturbed ground. Many of these nest sites may not be suitable for winter survival in adverse conditions. In New Zealand, Donovan (1997) recorded high nest density during the establishment phase in disturbed ploughed land at 137 nests/hectare for *V. vulgaris*. This density reflects the utilisation of potential nesting sites, many of which would not survive adverse weather conditions.

Table 1. Seasonal capture of *Vespula germanica* and *V. vulgaris* in Malaise traps at Warra (data pooled from 9 traps for each month).

Year	Month	*Vespula germanica*		*Vespula vulgaris*	
		Queens	Workers	Queens	Workers
1997	Nov	1	0	0	0
	Dec	7	0	0	0
1998	Jan	8	0	0	0
	Feb	0	2	0	0
	Mar	0	9	0	4
	Apr	0	14	0	14
	May	0	4	0	12
	Total	**16**	**29**	**0**	**30**
1998	Nov	3	0	0	0
	Dec	3	0	0	0
1999	Jan	0	0	0	0
	Feb	0	3	0	1
	Mar	0	57	0	5
	Apr	0	147	0	108
	May	0	41	1	81
	June	4	3	2	4
	Total	**10**	**251**	**3**	**199**
1999	Oct	4	0	0	0
	Nov	9	0	0	0
	Dec	24	0	1	0
2000	Jan	16	0	0	0
	Feb	0	4	0	4
	Mar	0	48	0	60
	Apr	0	47	0	60
	May	0	11	1	27
	Total	**53**	**110**	**2**	**151**
Total		**79**	**390**	**5**	**380**

Comparisons of the Warra site with New Zealand are valid as similar disturbance and climate effects enable prediction that the establishment phase will continue at Warra as long as logging and roading activity continues. Once these activities cease then over a period of several years the optimal sites will become permanently colonised and fluctuations in population will occur, tempered by weather conditions and food resources. In New Zealand 10% of studied nests over-wintered and were active for two to three seasons (Harris 1996).

Madden (1981) recorded the foraging loads of *V. germanica* at one site in Tasmania over several seasons and found that calliphorid flies were the most common prey, comprising 28.5% of total prey capture. Insects comprised

81% of foraging loads. Lewis (1975) found Diptera comprised 45.5% of protein loads, of which 23.5% were calliphorids and 18% muscids. In New Zealand, Thomas (1960) reported a marked decrease in the abundance of blowflies since *V. germanica* became established. At Warra the number of large calliphorid flies captured in the same Malaise traps was compared over time with the capture of vespine wasps. Figure 3 illustrates the average numbers of large calliphorids of four different species, captured over the years in the same traps used to sample *Vespula* populations. In 1997/98, when wasps were at low population levels during the establishment phase, numbers of calliphorids averaged over 40 individuals per month per trap during November-March then declined to 15 per month per trap in April-May. During the following summer of 1998/99, when the wasp population had increased 15 fold, calliphorids were trapped at 31 individuals per month per trap during November-February. During March-May, when wasp food gathering was at its peak, the trap catches of calliphorids declined to 2 individuals per month per trap. In 1999/2000 the calliphorid populations were low throughout the summer and declined further when high wasp numbers were present.

It is planned to continue monitoring the calliphorid and wasp populations for several seasons to investigate the possibility of long-term reduction of numbers of calliphorids and other prey species due to predation by *Vespula* species.

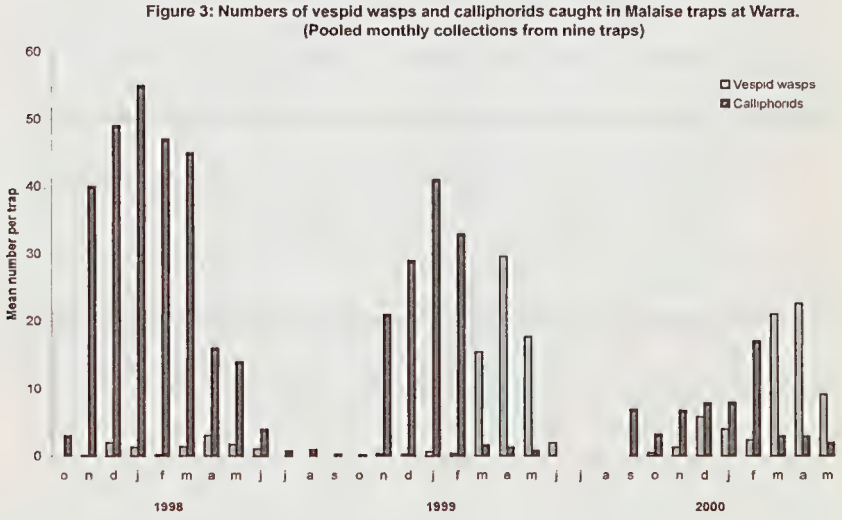

Fig. 3. Numbers of vespid wasps and calliphorids caught in Malaise traps at Warra. (Pooled monthly collections from 9 traps).

Discussion

There is little information on the impact of introduced vespine wasps on the native environment in Australia. In New Zealand the predatory effects of *Vespula* spp. on tipulid crane flies demonstrates the deleterious effect on populations of some native prey species. Up to 91% of tipulid species could be vulnerable to wasp predation (Toft and Beggs 1995). Those species of crane flies whose flight periods coincided with that of introduced *Vespula* wasps were potentially most vulnerable to direct impact from wasp predation.

Beggs and Rees (1999) examined the impact of introduced *Vespula* wasps on lepidopteran communities. The findings indicated that large free living lepidopteran larvae are particularly vulnerable, to the degree that some species whose larvae are most active at the time of peak wasp activity have virtually no chance of surviving to adults at moderate wasp densities.

Toft and Rees (1998) studied the impact of *V. vulgaris* on garden orb-web spiders in a beech forest. They found wasp abundance and the probability of spider survival were negatively correlated. The extrapolation from the model created predicts that the invertebrate taxa most vulnerable to wasp predation may have already been removed from that site ecosystem during the 40 years of wasp occupation.

Reducing populations of *Vespula* species by nest destruction has been attempted in New Zealand, with limited success because colonisation and reinvasion by foraging workers meant there was little impact on cumulative wasp biomass as measured using Malaise traps (Beggs *et al.* 1998). However, recent advances in insecticide baiting gives hope for reducing wasp populations at specific community sites such as picnic grounds, work areas such as vineyards, or unique ecosystems. Such a trial could be conducted at Warra where a 2 km wasp-free buffer currently exists between the LTER site and the South-West Conservation Area boundary. The establishment of a buffer controlled by summer trapping may prevent establishment of vespine wasps in the eastern section of the Conservation Area.

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